Suicide: the spatial and social components of despair in Britain 1980–2000

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In this paper we show that, by accounting for the varying influence of just three area indicators of social isolation, it is possible to predict the number of deaths due to suicide and undetermined injuries (most of which are suicides) across a great many areas remarkably closely. The exceptions to this model suggest that in a few unique areas of the country other local, often historical and cultural or intrinsically geographical factors matter also. These findings of the general predictability of suicide matter because suicide is such a common cause of death, particularly for the young. Between 1 January 1981 and 31 December 2000, the underlying cause of the deaths of 130 000 people in Britain were recorded as being directly due to suicide, or in all probability being due to suicide. Collectively, these thousands of personal stories are brought together here to show how a pattern of despair in Britain over this period was spread across the country, affecting different places and different groups in society to differing extents over changing times. The changing geography of despair can be shown to be largely the product of changing economic, social and demographic geographies. This paper is concerned with determining the extent to which the stories of suicide in Britain were more than the sum of thousands of individual acts of misery and the extent to which they reflected the changing social structure of the country. Quantitative analysis is used to identify possible key trends with a more qualitative set of interpretations placed on the possible meanings of these findings. The paper concludes by speculating on how current social trends may influence the future map of the extremes of despair in Britain.

key words Britain suicide modelling social isolation integration

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revised manuscript received 28 July 2003

Introduction

Suicide is amongst the most enduring subjects of long-term interest in the social sciences. Wide variations in recorded suicide rates found between different countries were used to provide one of the first examples of the potential effects of social organization on individuals and of how individual behaviour can be conditioned by the nature of the society in which each individual lives (Morselli 1881; Durkheim 1897). Suicide rates are now monitored as a key government health target (Department of Health 1999) both because they are thought to provide an indication of population mental health and, as for some groups in the population (young men), because they have been rising in recent years. Within human geography, however, the study of suicide has been relatively limited. Suicide is a harrowing and generally very rare event and each individual story will be complex, so forming a general view from the family and friends of victims of suicide is very difficult. Rare cases, particularly those involving political intrigue (such as the cases of Stephen Ward and David Kelly) make the headlines. Most cases receive little attention, but it is the bulk of

Trans Inst Br Geogr NS 28 442–460 2003
ISSN 0020-2754

cases, rather than the exceptions, which are most revealing.

In this paper we show how the geography of suicide reflects a great many of the more mainstream aspects of life in Britain that geographers concentrate on in other work, and in doing this we aim to bring into focus the damage that can be done through some aspects of the social organization of life in this country. This paper shows, for instance, how the economic geography of the changing availability of work has had a significant impact on the suicide rate in different places. Similarly, the social geography of human relationships, even when summarized as crudely as possible by whether people are married or not, is found to matter greatly. Lastly, the changing demographic structure of the country, most importantly through changing patterns of migration, is shown to also have a very important influence on the changing rates of suicide in different places. However, all these impacts vary for different age and sex groups. Who you are matters as much as where you live and what you do there in terms of your risk of suffering from the geographies of despair documented, albeit briefly, in these pages.

We also examine the exceptions to the general rules we have determined: the areas of Liverpool, Sheffield, Durham, Birmingham and the Welsh Valleys where suicides are surprisingly uncommon given the economic, social and demographic factors that tend to predict suicide rates so well elsewhere. Similarly, suicide rates can be shown to be higher than expected (after the models are applied) in the remote areas and islands of Scotland, remote rural areas in Cornwall, Northern England, in very poor parts of Glasgow and in a few isolated pockets of other generally less affluent towns and cities. However, in general, these places are geographical anomalies with interesting, but often geographically unique, stories to tell. In over 600 of the 641 parliamentary constituencies of Britain there are no exceptions that account for more than about two more or two less suicides a year than the model described here accounts for. It is perhaps the very predictability of suicide, that apparently most individual and selfish of decisions, and the surprise that comes from discovering this that has led to the enduring interest in suicide in social science. That, and the continued high rates of suicide despite much apparent social progress.

The formal geographic investigation of suicide dates back over 100 years (Moreselli 1881; Durkheim 1897). Morselli's investigation of suicide included detailed maps of rates across Europe as a whole, as well as within the nation states of England, Italy and France in which different regions were shaded to highlight the inter- and intra-national variations in suicide rates. In Durkheim's seminal study of suicide (1897), this mapping approach was taken a step further. Durkheim mapped levels of possible suicide risk factors (levels of alcoholism, wealth and family size) in France and compared their distribution with patterns of suicide. Morselli and Durkheim also explored the possible influence of 'cosmic' factors on suicide – investigating associations with soil composition, latitude, season and a range of other factors. Durkheim's studies of geographical variations in suicide within and between countries led to important insights into the aetiology of suicide. He provided quantitative evidence to support the view that the ten-fold differences in suicide rates between European nations seen in the nineteenth century could be understood, at least partly, in terms of differences in the dominant religion. States with high levels of Catholicism had lower levels of suicide than those that were predominantly Protestant. He replicated this finding when contrasting regional levels of suicide and Catholicism within Italy, Germany and France and suggested reasons why England was discordant from this general picture. He adopted a similar approach to investigating the effects of place – as indexed by levels of literacy, household size, levels of marriage – on rates of suicide using as geographic units the departments of France, the states of Germany and entire nations.

An important theme that emerged from Durkheim's findings was the view that national (and regional) suicide rates are influenced by the extent to which individuals are integrated within society. Integration at the time he was writing came through a variety of sources, including family support, together with religious, political and work affiliations. He noted that in highly integrated societies, where there appeared to be strong social bonds and a high degree of social cohesion, suicide rates were low. Lower levels of social integration on the other hand implied to Durkheim that people may not have adequate mechanisms of social support and they may therefore resort to individualistic solutions to their problems. To test the extent to which Durkheim's thesis may be true, census-based measures of social integration have been produced which usually combine various indicators of an

area's characteristics (Congdon 1996; Whitley *et al.* 1999). These characteristics typically include population turnover, the marriage rate, number of people living alone and similar measures. One problem with such indices is that they represent a combination of factors that are assumed to affect all people living in an area. In this paper, we move on from Durkheim's (1897, 208) general notion of social integration to more particular measures of integration that can be made of different groups of people living in the same areas. It could well be the case that social conditions in a particular area which represent disintegration for one group act as a marker for integration in another. For a young man, a seaside retirement town with few job opportunities and little to do may be a very depressing place to live, but perhaps not so for an elderly woman in the same setting. Conversely, a bustling city centre full of clubs and cafes may be an isolating place for an elderly woman to live.

For quantitative studies, the low rate of suicides makes the comparison of rates between areas problematic (e.g. Saunderson and Langford 1996). Furthermore, trends in suicide have been diverging for different groups in the population and so it may be presumed that any underlying drivers of these changes may also be different for these different groups. Most importantly, suicide rates are rising for some younger groups of men, but are generally falling for women and old people (Gunnell *et al.* 2003). This suggests that these different age and sex groups should be studied separately, again reducing the number of events to consider when spread across space. The study presented in this paper considers two ten-year time periods to ensure there are enough deaths occurring in each group of the population in each place and in each decade to reveal clearer patterns than could be seen before and to identify changes in those patterns over time.

Several studies have investigated geographic patterns of suicide at a national level (see, for instance, Griffiths and Fitzpatrick 2001). A common finding is that areas characterized by markers of low social integration (social fragmentation) – such as a high proportion of single-person households, divorced people and high population mobility in an area – have the highest rates of suicide (Ashford and Lawrence 1976; Whitley *et al.* 1999; Congdon 1996; Middleton *et al.* 2003a 2003b). Associations with levels of unemployment and socioeconomic deprivation have been reported in other analyses (Platt and Hawton 2000; Gunnell *et al.* 1995).

The study presented here was designed to explore and to try to measure the potential impacts of some of the key components of social integration measured separately for different groups of the population in different places and at different times, to ascertain to what extent each aspect of life in a place may influence rates of suicide in a particular demographic group of which they are a part. By comparing these influences between men and women, how they alter as people grow older and how they are changing over time, we aim to show a little more clearly how the organization of society in Britain appears to have impacted on the extreme despair that a minority of the population experience and that drives a very small minority to an early death. We are limited by the data available (for every place, for men and women, for different age groups and being consistently measured at different times) to considering three key components of social integration: migration, not working and being single. However, we defend these below as fortunately being sensible summaries of the general conditions we wish them to reflect. We initially limited our methodology to using the simplest of statistical techniques – linear regression analysis – so that our results could be readily interpreted by as wide an audience as possible, arguing that the large sample size that we are dealing with made use of such a simple technique less problematic than it otherwise might be. The referees of the first draft of this paper suggested we use more complex, but more appropriate, regression techniques and so we did this for the results reported here. For those interested in methodology, what was most interesting was that the use of more sophisticated techniques had almost no impact on the interpretation of our results (other than for those age and sex groups for whom suicide is most rare).

To conclude this introduction, it is vital to remember that the organization of society is only one part of the story of what drives people to suicide. Suicides occur in every society regardless of how it is organized. Furthermore, many suicides are related to factors that are not strongly influenced by the organization of society. In addition to this, our measures of the make up of society are necessarily crude due to what is measured about society; usually measured for other purposes. However, by disaggregating the components that we can study, our approach is less crude than the usual alternative of constructing a single index. Given these limitations, we can only hope to see

relationships that 'account for' some of the spatial variation in suicides in Britain. However, in view of the complexity of this behaviour, this might well be the majority of what can be accounted for at the aggregate level of places and it should provide us with some indication of what factors in the organization of society may be of most importance in the near future given current social trends.

Methods and data

The British censuses of 1981 and 1991 are used here to provide a series of measures of the extent to which places were socially integrated at the beginning of the 1980s and the 1990s. To ensure that we are comparing the lives of roughly equal numbers of people, our spatial units of analysis are parliamentary constituencies as used to elect members of parliament in Britain in 1997 and 2001. These are not just sensible spatial units in terms of population size, they also allow for the differentiation of many inner city areas from suburbs or remote rural areas, from urban hinterlands and of towns from collections of villages. The small area census data from earlier years have been aggregated to these units so that the same areas can be compared over time (Mitchell *et al.* 2002). Analyses using administrative geographies (such as local authority districts) suffer from comparing areas of greatly varying populations. Comparing the tiny county of Rutland with the huge district of Birmingham is hardly comparing like with like. Furthermore, the densely populated large local authorities tend to contain the greatest variations in mortality rates and thus their use hides those spatial variations.

We do not have access to comparable census or mortality data for Northern Ireland and so that province is excluded from this study. For the mainland of Britain, in each constituency, we have divided the population by sex and into six age groups: 16–24, 25–34, 35–44, 45–54, 55–64, 65+. We have not considered suicide under the age of 16 (which is extremely rare). The choice of these age and sex groups is largely constrained by the variables that were disaggregated by age and sex in the two censuses we use. For each age/sex group we can measure three pertinent aspects of potential social isolation in society in each area at each point in time. To reiterate, these are: the proportion of people who are single; the proportion who have recently (in the last 12 months) migrated into the area; and the proportion who are not in work.

Figure 1 shows the national proportions of people in each age and sex group who were in each of the three categories of social isolation as measured by the 1981 and 1991 censuses in each area. It is important to remember that these measures are often combined in studies of the possible social influences on suicide not only with each other, but also for all the different age and sex groups shown here (Whitley *et al.* 1999; Congdon 1996). What Figure 1 illustrates is that at different points in people's lives, different social conditions are more or less unusual. We might therefore assume at different stages in people's lives, and varying for men and women, the possible influence of being in a particular group, or more indirectly of living in an area with a large proportion of other people being in a particular group, might not be particularly unusual and hence not particularly isolating for different people in different places at different times.

In the year before the census dates of 1981 and 1991, between 15 per cent and 22 per cent of people aged between 16 and 34 had migrated to their current place of residence in Britain. Migration is relatively common at these ages. Conversely, less than five per cent of people aged over 45 migrated each year in Britain. Being a migrant at older ages is thus a much more unusual situation to find yourself in. The extent to which migration is socially isolating might thus be assumed to be higher for older people in Britain. Migration can thus be assumed to be more isolating with the fewer people of your age who migrate. Put another way, if you are a young migrant, you are likely to have more in common with a large proportion of other young people living in your area who have also migrated there in the last few years. It could be argued that if we had a measure of who was 'lonely' in each place in Britain this would be far more useful. We don't, but more important than that, loneliness can be the result of many things, just one of which is population mobility.

Figure 1 shows that there is an even wider variation by age and sex in a person's chances of not working in Britain. Not working is the norm for all people aged over 65 and for women aged over 55. However, between ages 25 and 44, only between 10 and 20 per cent of men do not work nationally. For women, not being in paid employment is much more common, as it is for everyone aged under 24. The extent to which being out of work is socially isolating is therefore clearly influenced by your age and sex. Actually, being in work at older ages

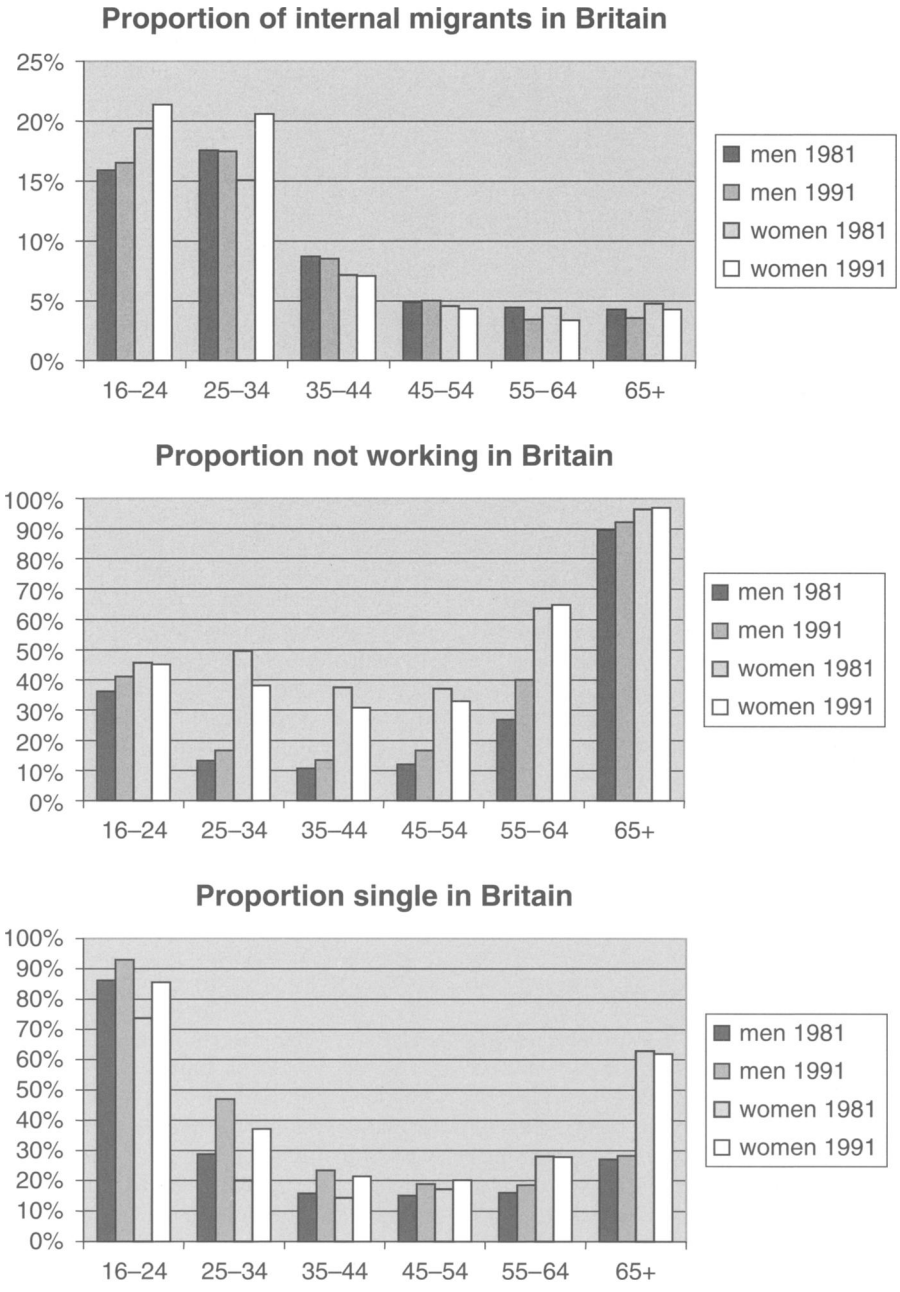

Figure 1 Measures of social isolation in Britain by age and sex
Source: 1981 and 1991 Censuses of Population for all of Britain

can put you in a small minority of your age group – and, as we see below, appears to correlate detrimentally with suicide rates. Once you begin to decompose simple measures such as unemployment by age and sex, the importance of personal context becomes very clear and the problematic nature of interpreting a general all age/sex group 'unemployment rate' becomes apparent. Again,

it could be argued that long-term unemployment might be a more appropriate measure. Unfortunately, various governments made over 30 changes to the official definition of unemployment over this period and so any consistent measure of the changing geography of long-term unemployment is almost impossible to derive. The measure we use is whether people self-defined themselves to be not employed at the census dates, a measure largely independent of official manipulation.

Finally, it is normal to be single beneath the age of 25, and over the age of 64 for women. However, being single between ages 35 and 64 puts you in a small minority of the population of your age and sex group and is presumably more socially isolating (although the extent to which this very broad generalization may hold should be expected to reduce over time as increasing numbers of people cohabit). The statistics shown in Figure 1 are national averages and therefore mask the large amount of geographical diversity in the extent to which people may find themselves to fall into different categories. Nevertheless, they demonstrate the very great influence of age and sex on all these potential measures of social isolation. How old you are and whether you are male or female is usually more influential than where you live in determining your chances of being in a particular social group. Of all our measures, the proportion of people who are either single or married initially appears to be the most tangential measure of whether they are likely to be in a happy relationship. We would agree with this, but there is no census box to tick 'are you happy', and despite the bad press that marriage often gets, analysis of the British Household Panel Study has found marriage to be the single most effective contributor to personal happiness (apparently worth the same as an annual £72 000 rise in income! Strategy Unit 2003). Finally, marriage rates will, to a small extent, reflect religious beliefs, which have been known since Durkheim's work to influence suicide rates.

In total, we are considering 641 areas, two time-periods, six age groups and both sexes for three variables of potential influence. We did model the groups together too, but found that the differences between the coefficients by age and sex were great enough to suggest that separate models were more appropriate (see below). Thus, in any particular area at any one period, we have just three measures to model the suicide rate for each group in the population. As these are the same three measures for all groups, we can then compare their relative predictive powers between age/sex groups and time periods to gauge the extent to which these models suggest that different factors matter more or less for these different groups of the population, as expressed through the complex 'response' of suicide to social isolation.

The mortality data used for this study were obtained from the Office of National Statistics and the General Registrar's Office for Scotland. All deaths recorded to have occurred between 1981 and the end of 2000 were included where they had a valid postcode (well over 99% of cases). The postcode of usual residence was used to assign the death to a parliamentary constituency. Causes of death were recorded using the International Classification of Deaths version 9 (ICD9) in all cases except for Scotland in 2000, where causes of death were recorded by ICD10. These causes were converted back to ICD9. All causes recorded as ICD9 E950–E959 ('Intentional self harm') and E980–E989 ('Injury undetermined whether accidentally or purposely inflicted') were included under the definition of suicide used here. The resident 1981 population and the 1991 population corrected for the under-enumeration of that census were used as denominators for the calculation of suicide rates. From here on, for simplicity, we use the terms 'suicide' to refer to all these deaths, whether 'undetermined' or not.

We chose to include undetermined deaths (those given open verdicts by coroners) because previous analyses of national suicide data for England and Wales have shown that such deaths tend to follow a very similar pattern to suicides – other than there being slightly more doubt involved over the level of intent (Charlton *et al.* 1992; Kelly and Bunting 1998). All violent or unnatural deaths are investigated by coroners in England and Wales, and Scotland; based on their inquiries, a verdict of homicide, suicide, accidental death or an open verdict is given. Where there is uncertainty about whether the deceased intended to kill themselves, an open or accidental verdict may be given. Research indicates that most deaths given an open verdict are in fact suicides (Linsley *et al.* 2001).

Changes in the lethality of commonly used methods of suicide can have important impacts on secular trends in suicide and more recent trends may have had an impact upon the spatial distributions that we are studying here. Trends in Britain in the last four decades have been influenced by changes in the toxicity of the domestic gas supply (Kreitman

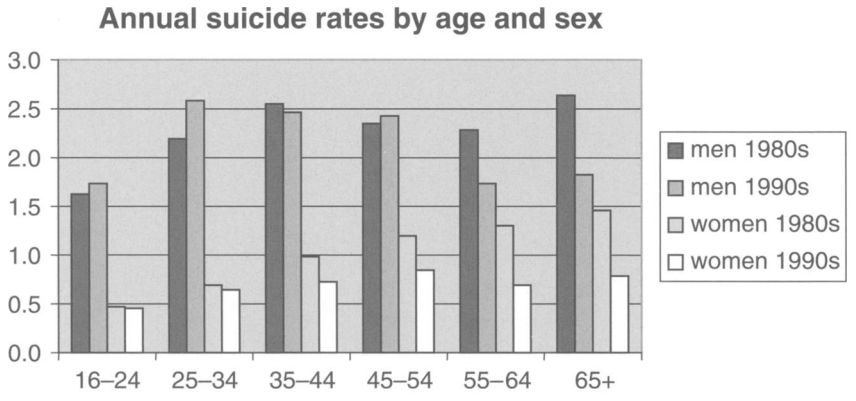

Figure 2 Suicide rates in Britain by age and sex 1981–1990, 1991–2000
Source: Individual mortality records for Britain 1981–2000 and population estimates. Rate shown is per 10 000 per year

1976), fitting cars with catalytic converters (Amos 2001) and the toxicity of drugs commonly taken in overdose (Gunnell *et al.* 1999a). Figure 2 shows the suicide rates for the 12 age/sex groups during the 1980s and 1990s. The rates are higher for men and rose for men aged under 35, but fell for men aged 55 and over. The lower rates for women fell even further for women aged 35 and over in the 1990s. These changes are most likely due to the changing lethality of methods used at different ages at different times, as just discussed (in particular, the reduced toxicity of certain prescribed drugs), but they may also be partly due to the rising social status of women in society.

The rates of suicide have changed markedly in some groups of the population in differing directions, while the underlying measures of social integration (in Figure 1) suggest that changes in these factors between the 1980s and 1990s have generally been less striking. However, for men aged 25–34, their rising rates of not being in work and of being single coincide with a rising suicide rate (Gunnell *et al*. 1999b; but see Crawford and Prince 1999). For this reason, we should not in general expect changes in social isolation to be an explanatory factor for the changes in suicide rates in Britain during the period 1981–2000. However, as we show below, the geographical pattern of social isolation is strongly coincident with the geographical distribution of suicide rates in Britain, and so we are interested in for whom that relationship is strongest and how the possible geographical relationships between suicide rates and social isolation have been changing over time for different groups of the population.

To study the strength of the spatial relationship between measures of social isolation and suicide, we first used simple multiple linear regression, where we attempted to predict the rate of suicide in each area at each time period by determining the equation which best predicts the rates of suicide for each age/sex group, given the three measures of isolation we have for that group in each place at each time period. There is a plethora of more sophisticated techniques we could have applied to this data. Such techniques range from Poisson and negative binomial regression (Mitchell *et al*. 1998), empirical Bayes estimates (Saunderson and Langford 1996) to multi-level modelling (Jones *et al*. 1991), a combination of these and more.

As mentioned above, the referees of the first draft of this paper helpfully suggested that a more sophisticated technique would be appropriate and so we remodelled the associations with suicide rates using negative binomial regression in Stata version 7.0 (StataCorp. Stats Statistical Software: release 7.0. College Station, Texas: Stata Corporation 2002). Negative binomial regression is the preferred modelling approach for count data where the counts have extra-Poisson variation (overdispersion). For each constituency, we used the number of suicides within the given age/sex band for the particular ten-year period as the outcome variable, and the age/sex-specific population of that constituency as the offset. We present the results in terms of the

increase (or decrease for values <1.00) in relative risk of suicide per ten per cent increase in each of the three predictor variables (migration, not working, proportion single). The results were almost identical in implication to those derived from more simple modelling, have the advantage of using a more generally accepted technique, but have the disadvantage of using methods not familiar or easily accessible to most geographers (the simple model, not reported here, was undertaken in Excel).

Lastly on methods, in the complete dataset, containing age and sex-specific social, economic, population and suicide data, we tested how the association of suicide with the three census variables varied across the different age groups or in males versus females. We fitted age–risk factor and sex–risk factor interaction terms to the model. There was strong evidence that associations with living alone, migrancy and not working differed with age and sex (p interaction <0.001 for each risk factor in relation to age and sex). Given this, it made sense to model the differing age and sex groups separately.

Results

Tables I and II below give the basic results, for men and women respectively, of applying negative binomial regression equations to predict suicide rates for each age group for the 1980s and then the 1990s at the level of parliamentary constituencies. Taking the example of men aged 15–24 in the 1980s, the tables can be read as follows: all of the factors are significant at the five per cent level or less except for 'being single', which is not a strong predictor of an area's rate for this age/sex group at this time (which intuitively makes sense given how common being single is at these ages). The suicide rates for this group in any particular area are

Table I Age-specific relative rates (95% confidence interval) of suicide[a] for males in the 641 parliamentary constituencies of Britain in relation to the proportions of individuals within that age band who are single, not working or have recently moved into the area (migrants)

	Age group					
	15–24	*25–34*	*35–44*	*45–54*	*55–64*	*65+*
1980s						
Single	0.95	1.08	1.21	1.17	1.28	1.18
95% CI	0.88–1.03	1.03–1.13	1.13–1.29	1.09–1.25	1.21–1.35	1.11–1.24
p-value	0.205	0.003	<0.001	<0.001	<0.001	<0.001
Not working	1.10	1.27	1.16	1.05	1.01	0.92
95% CI	1.03–1.16	1.03–1.13	1.09–1.23	0.99–1.11	0.98–1.05	0.87–0.98
p-value	0.002	0.001	0.001	0.117	0.439	0.006
Migrant	1.22	1.30	1.61	2.71	1.84	1.71
95% CI	1.15–1.30	1.17–1.45	1.39–1.88	2.19–3.34	1.50–2.25	1.36–2.15
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1990s						
Single	0.62	0.93	1.09	1.23	1.21	1.18
95% CI	0.54–0.71	0.90–0.96	1.04–1.15	1.17–1.29	1.14–1.28	1.11–1.24
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Not working	1.17	1.39	1.28	1.04	1.04	0.84
95% CI	1.12–1.23	1.34–1.45	1.23–1.34	1.00–1.08	1.00–1.07	0.76–0.91
p-value	<0.001	<0.001	<0.001	0.072	0.030	<0.001
Migrant	1.08	1.35	1.67	2.76	3.66	2.57
95% CI	0.99–1.19	1.25–1.45	1.42–1.97	2.32–3.28	2.58–5.20	1.94–3.41
p-value	0.086	<0.001	<0.001	<0.001	<0.001	<0.001

[a]Relative rates are derived from negative binomial models. Coefficients represent the change in relative rate of suicide in an area per 10% increase in the proportion of people, who are single, not working or have recently moved to the area. Values >1.00 imply increasing levels of the factor are associated with an increased risk of suicide, values <1.00 imply increases in the factor are associated with reduced risk

Table II Age-specific relative rates (95% confidence interval) of suicide[a] for females in the 641 parliamentary constituencies of Britain in relation to the proportions of individuals within that age band who are single, not working or have recently moved into the area (migrants)

	Age group					
	15–24	*25–34*	*35–44*	*45–54*	*55–64*	*65+*
1980s						
Single	1.07	1.38	1.36	1.30	1.20	0.97
95% CI	0.98–1.17	1.29–1.49	1.26–1.46	1.20–1.41	1.11–1.30	0.90–1.05
p-value	0.133	<0.001	<0.001	<0.001	<0.001	0.492
Not working	1.13	1.04	0.93	1.02	0.99	0.64
95% CI	1.00–1.27	0.94–1.15	0.85–1.01	0.95–1.10	0.93–1.05	0.53–0.79
p-value	0.044	0.413	0.092	0.512	0.657	<0.001
Migrant	1.42	1.14	1.51	1.86	2.10	1.79
95% CI	1.29–1.56	0.95–1.36	1.17–1.95	1.38–2.51	1.56–2.84	1.35–2.37
p-value	<0.001	0.154	0.002	<0.001	<0.001	<0.001
1990s						
Single	0.92	1.16	1.28	1.31	1.33	1.16
95% CI	0.81–1.06	1.12–1.21	1.20–1.38	1.23–1.40	1.23–1.44	1.06–1.27
p-value	0.250	<0.001	<0.001	<0.001	<0.001	0.001
Not working	1.31	1.18	1.14	1.05	0.94	0.46
95% CI	1.20–1.44	1.09–1.27	1.04–1.24	0.98–1.12	0.87–1.01	0.36–0.58
p-value	<0.001	<0.001	0.004	0.185	0.103	<0.001
Migrant	1.21	1.27	1.89	3.17	3.25	1.50
95% CI	1.06–1.40	1.14–1.42	1.38–2.57	2.32–4.31	2.00–5.28	1.06–2.14
p-value	0.006	<0.001	<0.001	<0.001	<0.001	0.022

[a]Relative rates are derived from negative binomial models. Coefficients represent the change in relative rate of suicide in an area per 10% increase in the proportion of people, who are single, not working or have recently moved to the area. Values >1.00 imply increasing levels of the factor are associated with an increased risk of suicide, values <1.00 imply increases in the factor are associated with reduced risk

modelled to be the mean rate for this group as a whole multiplied by 1.22 for every ten per cent rise in the migration rate, multiplied by 1.10 for every ten per cent rise in the proportion of these men not working, multiplied by 0.95 for every additional ten per cent of the population who are single. The coefficients in the table can be read as the expected difference in suicide rates in each area associated with a ten per cent difference in the level of the variable they relate to. In Table I as a whole all but five of the coefficients are greater than 1, so higher levels of the predictors are generally associated with higher levels of suicide. Beneath each coefficient, the 95 per cent confidence interval is given and the significance of the coefficient to the regression model is reported.

For men, the only coefficients which are associated with lower local suicide rates are being single at ages 15–24 and not working over age 64 in the 1980s and being single between ages 15 and 34 and again not working over the age of 64 in the 1990s. Not working was positively, but insignificantly, associated with higher suicide rates in men aged between 45 and 64 in the 1980s and only weakly associated with suicide rates for those aged between 45 and 64 in 1990s. Migration was more weakly associated with the suicide rates in men aged under 24 in the 1990s. All other coefficients were significant and positively related to higher local suicide rates (but to varying degrees as discussed below).

In general (using results from the linear modelling), the regression equations fit better (in terms of R^2 values) in the 1990s as compared to the 1980s and the fits are best for men between ages 35 and 54 and for women between ages 25 and 44. In almost all cases the fit of the model is stronger for men than for women (partly due to there being fewer female suicides). In no cases do these models explain a majority of the spatial variations in suicide rates. Nevertheless, the changing pattern of

the coefficients by age and sex as briefly discussed above are very interesting and the majority of the coefficients are significant predictors of suicide rates at the five per cent level (31 out of 36 for men, 26 out of 36 for women). Where the coefficients are (or have become) lower than one is also intriguing and appears to make intuitive sense; but here we must caution against reading too much too exactly into these findings. They concern the general relationships between measures of the behaviours of large groups of people. It is quite possible for instance, although unlikely, that elderly people who are not working are more susceptible in areas where more elderly people than average work. More likely such areas are places where elderly people with fewer resources than average live and thus a disproportionate number have to work and a disproportionate (but not necessarily related) number find living too hard.

The following graphs (Figure 3) allow easier interpretation of the data presented in Tables I and II, and encourage comparison of the changing relative spatial importance of different factors for different groups. They highlight interesting trends in the magnitude of the influence of different factors on suicide rates as age increases and between the two sexes. Curves have been fitted to the coefficients in the graphs as we hypothesize that these relationships are changing fairly smoothly with age. Associations with migration were stronger than were those with the other factors examined. The first graph charts the coefficients for migration from the 24 separate models. High migration into an area has its lowest effects on the population aged under 35 for whom migration is a more common activity (see Figure 1). The ecological influence of migration peaks for men aged 55–64 in both the 1980s and 1990s. At these ages the proportion of the population dying from suicide over ten years increases roughly three-fold for every additional ten per cent migrating into an area in a year at the start of those ten years. The greatest influence in any one constituency of this factor is in (what is now) the Cities of London and Westminster constituency where, in the 1980s, 40 per cent of this age-group migrated in between 1980 and 1981. The suicide rate in the 1980s in this constituency for this age and sex group was 9.6 per 10 000 per year, over four times the national rate.

The second graph in Figure 3 shows how the influence of living in an area where many people are not working is strongest for men between the ages of 25 and 44 and that the importance of this factor rose over time for these groups. For the most extreme constituency in the 1990s, Liverpool Riverside, where 44 per cent of men aged 25–34 were not working in 1991, the suicide rate in this area in the 1990s for this group was 3.0 per 10 000 per year. The model over-predicts suicide rates here, but as we see later Liverpool is a special case and Liverpool Riverside is one of a group of constituencies where the models in aggregate tend to over-predict the expected number of suicides there, given prevailing social conditions.

The proportion of people not working in an area has almost no effect on suicide rates for people aged between 45 and 64. Interestingly, over the age of 64 the higher the proportion of people not working at these ages, the lower the local suicide rate, this effect being strongest for women in the 1990s. Because all four coefficients (for men and women for both the 1980s and 1990s) are lower than one, it would appear that this detrimental impact of elderly people working on the suicide rates of the elderly is unlikely to occur by chance. All four coefficients were significant at the five per cent level, as Tables I and II demonstrated. Put another way, for people of retirement age, those living in areas where more than average people are actually retired are at significantly lower risk of suicide in their old age.

The third graph in Figure 3 also shows how a factor thought to influence suicide rates can have opposing effects at different ranges of the age scale. Living in areas where a high proportion of your age and sex group are single was associated with reduced suicide rates for the youngest age group of men in the 1990s and a small detrimental effect for older groups. A similar effect is seen for men aged 25–34 by the 1990s. For women, the negative influence of living in an area with a high proportion of single people rose to a peak around ages 25–34 in the 1980s and then fell; however, the peak shifted to 55–64 in the 1990s. For men, the peak occurred in later years at both decades. Looking in particular at men aged 45–54 in the 1990s, the area with the highest proportion being single was Holborn and St Pancras, 46 per cent being single at these ages. The rate there over the ten years of the 1990s was 4.6 per 10 000 per year, 2.2 per 10 000 per year higher than the national average rate of 2.4 per 10 000.

In general, the 24 models cope reasonably well, with areas of unusually high or low suicide rates. The overall fits of the models are weaker where there appears to be a higher degree of apparently

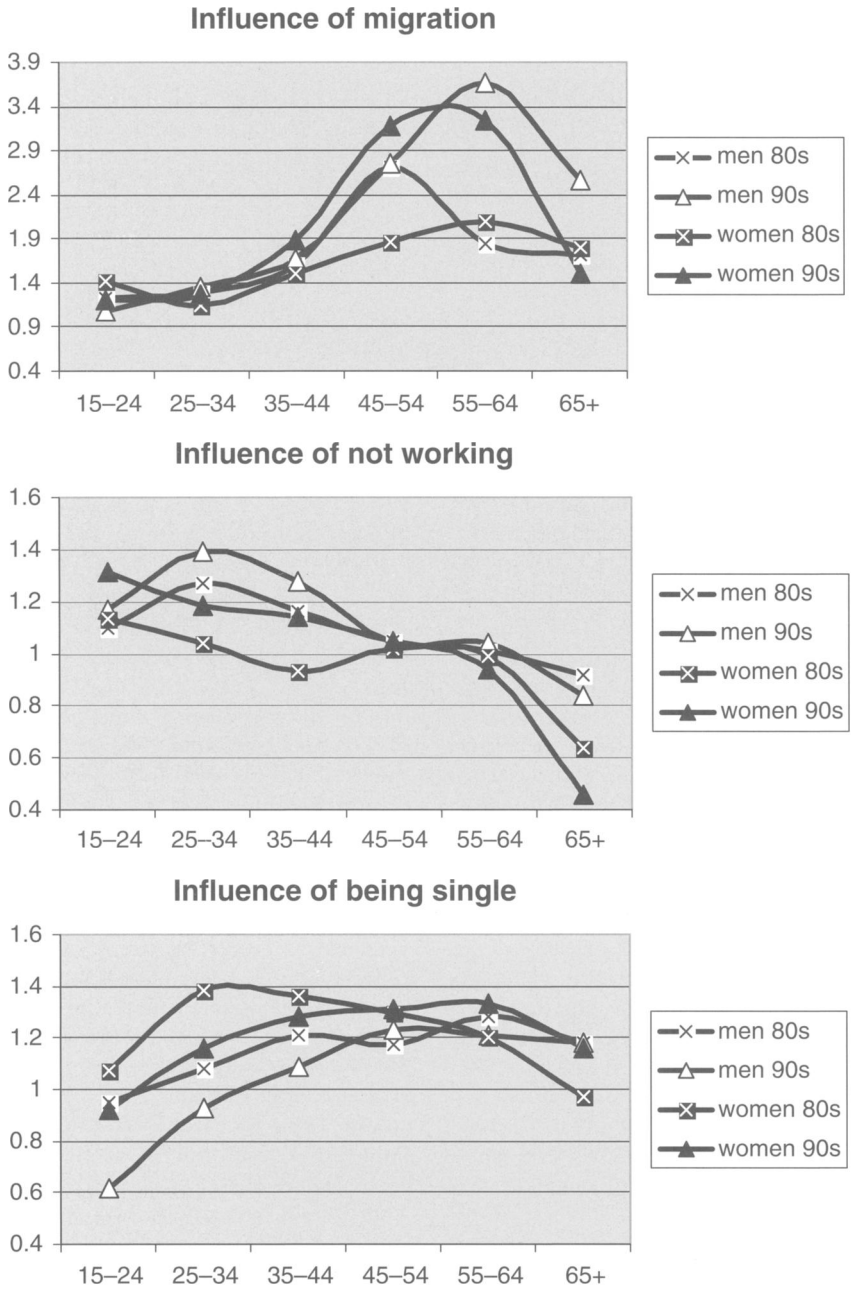

Figure 3 Influences on suicide by age and sex 1981–1990, 1991–2000
Source: Likelihood ratio coefficients from Tables I and II

random variability in suicide rate in what otherwise appear to be areas of quite average social conditions (see Figure 4 and below). When we consider areas which are not modelled well (below), a variety of possible factors are found rather than one or two key variables being missing from these models.

Finally, we can consider where there appears to have been a significant large change in the influence

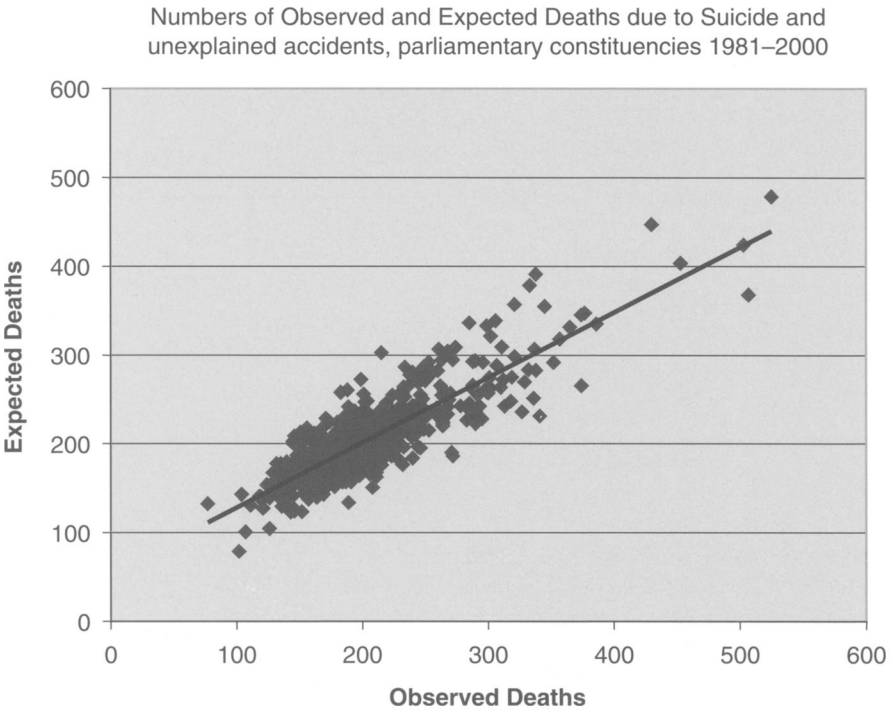

Figure 4 Aggregate fit of the 24 separate models for all areas. (The observed numbers of deaths are the total of all those which took place within each constituency over the 20 years. The expected number are the sum of the 24 separate linear models, multiplying for each constituency for each age and sex group and at each time period the numbers of people living in a particular social situation by the coefficient from the model for the estimated effect of living in that situation on the group suicide rate)

Source: Mortality data and the results of applying all 24 models

of a particular factor on suicide. We do this by noting which coefficients have 95 per cent confidence intervals that do not overlap between the two decades. Four significant changes have occurred:

- For men aged under 35, the beneficial effect of living in an area where being single is more common has increased.
- For people aged 35–44, the harmful effect of living in an area where many men of these ages do not work has increased.
- For men aged 55–64, the harmful effect of living in an area of high migration has increased.
- For women aged 25–34, the harmful effect of living in an area where many are single has fallen, for younger women the beneficial effect has risen, while for women aged 65+ harmful effects have risen.

Reliability of the model

A conventional multiple regression model only 'explains' a minority of the geographical variation in suicide rates for any particular age and sex group of the population in any one ten-year period. Proportions of variance accounted for through negative binomial regression are less simply described. However, when all 24 separate models are put together to predict the total number of suicides in any one place over 20 years the fit of the model appears to be very good (see Figure 4), with the correlation between the number of observed and expected deaths due to suicide being 0.856 (the same correlation to three decimal points being achieved through either method of modelling). This suggests that it is mainly random variation (which is cancelled out when we aggregate) which is responsible for any apparent

Table III Areas where the models over-predict suicides in total 1981–2000

Parliamentary constituency	*Observed*	*Expected (from model)*	*Difference (%)*
Islwyn	77	134.0	–74
Aldridge-Brownhills	104	151.7	–46
Walsall North	146	206.4	–41
Hackney North and Stoke Newington	215	302.6	–41
North Durham	145	201.9	–39
Liverpool, West Derby*	183	254.7	–39
Sheffield, Brightside	151	209.7	–39
Walsall South	150	208.1	–39
Bootle*	156	214.0	–37
Mole Valley	145	198.9	–37
Sheffield, Attercliffe	132	180.1	–36
Liverpool, Walton*	199	267.1	–34
Hendon	188	252.1	–34
Enfield, Southgate	154	204.4	–33
Knowsley South*	171	226.0	–32
Louth and Horncastle	153	202.1	–32
West Bromwich West	155	202.1	–30
Blaenau Gwent	135	175.9	–30
Knowsley North and Sefton East*	174	225.3	–30
North West Durham	162	209.4	–29

Source: Mortality data and the results of applying all 24 models. The difference is the percentage fewer deaths observed compared to model predictions

Table IV Areas where models under-predict in total 1981–2000

Parliamentary constituency	*Observed*	*Expected (from model)*	*Difference (%)*
Inverness East, Nairn and Lochaber	272	183.6	33
Ross, Skye and Inverness West	271	186.9	31
Caithness, Sutherland and Easter Ross	189	131.6	30
Halifax	327	231.4	29
Glasgow Shettleston	341	243.1	29
Aberavon	208	150.5	28
Glasgow Springburn	374	270.9	28
Vauxhall	507	375.5	26
Western Isles	102	76.1	25
Banff and Buchan	232	173.7	25
Brighton, Kemptown	313	236.1	25
Argyll and Bute	240	181.6	24
Truro and St Austell	295	225.6	24
Central Fife	211	162.3	23
Glasgow Anniesland	290	223.4	23
Blackpool North and Fleetwood	318	245.1	23
Glasgow Maryhill	336	259.1	23
Rochford and Southend East	289	226.1	22
Slough	283	221.5	22
Pendle	246	192.7	22

Source: Mortality data and the results of applying all 24 models. The difference is the percentage excess of deaths predicted over and above those which occurred

weakness in the individual models. In looking at where the overall fit of the models is worse, we can perhaps begin to see other geographical factors that might be influencing the rates of suicide in particular areas. Table III lists the 20 parliamentary constituencies where the number of suicides is over-predicted the most and Table IV lists the 20 where the rate is under-predicted the most. These

places are unusual because their rates of suicide are unusually high or low, not because of an artefact of the particular model used to predict their suicide rates.

Of the top 20 areas where we would have expected there to have been more deaths due to suicide than there were, five are in Merseyside (marked by an * in the table) in an area where traditionally there have been a high number of practising or believing Catholics. However, until 2001 Census results are released we will not be able to confirm any religious influence (and even then different Christian denominations will not be differentiated). It is intriguing that a factor such as religion which was identified at the very beginning of the social study of suicide may still be important today (Durkheim 1897). For more recent studies of the potential importance of religion, see Neeleman and Lewis (1999) and Neeleman *et al.* (1997).

Of the remaining 15 areas in Table III, several others are also places which attracted a high level of Irish immigration in the past (such as those in County Durham) and hence which may still have unusually strong Catholic communities. Others have distinctive and larger than average ethnic minority populations as identified by the 1991 census (e.g. Hackney), again with possible high concentrations of people adhering to religions that proffer strong views on suicide (or which help build strong communities that this form of modelling clearly misses).

Table IV lists those places where there have been more suicides than our models would predict. Again the discrepancies are small – between 26 and 131 more deaths in each place over 20 years than we would predict from their social circumstances (1–7 more deaths per year). Many of the top 20 areas where there were more suicides than the model predicted are some of the poorest places in Britain. Parts of Glasgow and Manchester stand out here (but, interestingly, not Liverpool – areas of which appear in Table III above). Some very remote rural areas also have higher numbers of suicides than the models in aggregate can account for: remote parts of Scotland and Cornwall, for instance. The ecological effects of poverty and/or extreme rural isolation (Middleton *et al.* 2003a 2003b) may thus be missing from the model, but there are an equal number of places in the top 20 under-predicted constituencies where neither of these factors are in place. Why, for instance, should suicide rates be higher than expected in Slough unless John Betjeman's observations on that area were particularly apposite? In general, when looking at these unusual places the degree to which they diverge from the general model is small and explicable in a number of cases as being probably due to factors not well correlated to the three we have used to model local suicide rates nationally.

The above two tables concentrate on the 40 areas out of all 641 British parliamentary constituencies for which the models work least well. Figure 4 shows the relationship between the observed and expected number of deaths for all constituencies and illustrates how a series of individual models, none of which account for a majority of the variation between areas in suicides for their particular age and sex groups, can produce an aggregate model in which the large majority of the variation between areas is accounted for. As we suggested above, the most likely explanation for this is that the errors from the various individual models tend to cancel each other out at the aggregate level. This suggests that those errors were largely random. Thus, by accounting for the varying influence of just three social indicators of isolation for the different age groups, sexes and at different time periods, it is possible to predict the number of deaths due to suicide and undetermined accidents across a great many areas quite closely. That does not, however, mean that what we have measured explains the rates, simply that it either does, or alternatively, that our measures simply correlate well with whatever actually does explain them.

Discussion: one person's meat is another's poison?

Using social statistics to model the number of deaths by suicide for relatively small geographical areas and for particular age and sex groups would not normally be expected to produce results that generate an extremely close fit between the observed and expected numbers of cases. Even looking at deaths over 20 years, there are still areas where for particular age and sex groups no deaths from this cause are recorded and the deaths rates being modelled are still very small with a high degree of randomness to their distribution. Furthermore, expecting three crude ecological factors to account for the majority of the spatial variation in suicide rates assumes a world in which the major influences on people's lives are three measures made of the average state of the lives of

the nearest (at most) 5000 people to any one individual at two points in time (1981 and 1991). The fact, therefore, that a very large amount of the spatial variations in suicide rates between areas can be modelled by just three social factors is thus remarkable and requires careful interpretation.

The three factors that we have measured may well be proxies for other things that influence suicide rates. Below we take each factor in turn and suggest what proxies might be at play. What is equally surprising about how well these models fit in aggregate is that they only look at the circumstances of people of the same age and sex as the 'at risk' group. The models take no account of the social circumstances of people of the opposite sex or of all other ages. One would expect that if a woman lived in an area where a great many men were out of work then her life might be somewhat blighted by this, but we do not try to take account of these influences (we have looked at some of these statistical relationships and found them not to be at all strong – i.e. we tried to model the rates of suicide of men of a particular age using the social circumstances of women of that age as well as men's and vice versa). What is also surprising is that two snap-shot measures taken in the first year of a ten-year period should have a strong predictive effect for the subsequent ten years. Rates of unemployment change quickly. Local unemployment rates in 1981 and 1991 are hardly a good guide to worklessness in 1989 and 1999.

Firstly, the rate of recent in-migration was found to be a significant predictor of local suicide rates for all groups other than men aged 16–24 in the 1990s and women aged 25–34 in the 1980s. Recent in-migrants might themselves be at greater risk of suicide, presumably, on average, having fewer local social contacts in the area they have migrated into than those that they had left behind. More importantly, a high rate of in-migration in one year in an area suggests that many more of the population living there will have been migrants in the less recent past. Additionally, for those people living in the area for longer, their neighbours and potential local friends are more likely to have changed recently and thus local social ties in general are likely to be more fluid. Why though would this have its most detrimental effects upon men and between the ages of 35 and 64? Men are traditionally seen as less adept at maintaining social ties and so perhaps migration can increase the chances of them losing the ties they do have as physical distance increases. Below the age of 35 migration is more common, almost becoming expected for people aged 18–21. Over the age of 64, you progressively begin to lose more local friends and neighbours of your age from death than from them moving physically away. Also in old age, living in an area of relatively high in-migration for your age group may simply imply that you have moved to a 'retirement area', which by definition should expect a high rate of in-migration (but not necessarily of out-migration as, again, people leave through death rather than migration). The fact that the relative influences of migration (under age 55) appear to have remained stable between the 1980s and 1990s suggests that these are long-term influences. Explanations for the largest change there has been – the influence of migration rising for men aged over 55 and women aged over 45 – are unclear and require further research.

Secondly, the rate of people not working appears to only have a strong detrimental effect for men aged between 25 and 44 and women aged 15–24, but that effect increased in intensity between the 1980s and 1990s. Unemployment is known to be associated with an increased risk of suicide at both the individual and population level (Lewis and Sloggett 1998; Gunnell *et al.* 1999b). A relatively high local rate of unemployment also tends to imply that jobs in general are less secure in a particular area and that those jobs that are there may be less well-rewarded financially. Thus the impact of unemployment may also be wider than simply affecting the unemployed themselves. The consistent categories of economic activity used in this study also included students as 'not working' and thus the small significance of not working below age 25 is not unexpected. What was surprising was to find all the ecological effects of the local proportion of people not working to collapse to near unity for people between the ages of 44 and 65. Perhaps the group of men of these ages who could choose to retire early saw beneficial effects from this which balanced out the negative effects of being forced not to work for those men of these ages that did want (or had) to work? Over age 64 the picture is clear again. Living in a place where people over retirement age tend to work increases the chances of someone over this age of dying from suicide. Perhaps where you cannot choose to enjoy your retirement without working (and/or if your neighbours cannot), this appears to indicate that there is slightly less to live for – particularly for women aged over 64.

Lastly, the influence of living in areas with a high proportion of people who are single in your age group appears most detrimental for people aged over 34. For women in the 1980s aged under 35, this was one of the few influences which had a greater negative effect on them than on men. However, the influence of being single has fallen for women in the 1990s in general (except above age 55). Our consistent measure of being single is actually of not being married and so as cohabitation increases (which is measured as being single here) it is not surprising to see the influence in younger people fall. It is thus somewhat surprising that the influence has not fallen for men aged 45–54. Just as migration and not working can be proxies for other things, so too can being single. Most obviously, people are less likely to have (or be living with) children if they are single and having responsibilities for children reduces an individual's chance of dying from suicide (a decreased risk of suicide has been found for mothers of babies in their first year of life; Appleby 1991). Conversely, as being single becomes the norm for younger age groups, then it is interesting to see the local rate becoming an apparently protective factor for men as a group aged under 35 by the 1990s. Put another way, there are more suicides than average in areas where men tend to marry younger now-a-days. However, these areas also tend to be poorer areas and so it would be misleading to assume a direct influence of young marriage on raising suicide rates.

Conclusion and the future map of suicide

In general, the findings in this paper suggest that suicide is as much influenced by social circumstances in 1980s and 1990s Britain as it has ever been. Suicide rates vary greatly between different places and for people at different ages and of different sexes. Given the trends that we have identified, what might the future geography of suicide be? Migration is the social component that had the most stable influence beneath age 45 over the two decades we looked at here and thus we might expect the detrimental impact of migration to continue. However, for older men and women, living in a place of higher than average population turnover appears to also be becoming more traumatic for the very small minority who do die from this cause. It is difficult to speculate over the possible reasons for the increasing importance of migration to this group.

For younger people aged between 24 and 45, the factor that grew most in influence was of the proportion of men of their ages not working in their local area. Living in an area where being out of work was more common than average appeared to have an increasingly detrimental effect. Although the importance of work is also rising for women, it has its greatest effect upon men. Here we appear to be identifying places where men are less likely to be able to fulfil their allotted social roles rather than places where they are less likely to receive social support (although much social support is received through the workplace). Why, though, should living in an area where it is hard to find work have increased in its detrimental influence over time for men aged 25–44? These are the ages at which men are most likely to be in work (see Figure 1). In the 1980s, areas of high unemployment were more spatially concentrated as traditional manufacturing and extraction (mining) industries closed. In the 1990s, as unemployment became far more evenly spread across the country (Dorling and Woodward 1995) and as many of those who could not find work in the 1980s found work, unemployment may have become stigmatized as more of a personal failing over time. If this were the case, younger men might be more inclined to blame themselves for being out of work or in less secure or well-rewarded employment (as poor pay is more likely to prevail in areas of high unemployment). A more competitive, individualistic marketplace for labour could well see the detrimental influence of being out of work rise for younger men in future years. For younger women too, work is rising in importance. Most significantly, we have seen the proportion not working change from being associated with lower than average suicide rates in the 1980s for women aged 35–44 rising to being associated with higher than average rates in the 1990s for this group. Looking into the future, we can speculate that lacking work for younger men, and the importance of work for younger women, may grow in importance as a factor influencing area suicide rates, while at post retirement ages having to work or living in an area where elderly people need to work could well grow in importance too.

Finally (and for both young men and women), the impact of living in areas where a higher than average proportion of other men of your age are single has fallen between the 1980s and 1990s. For the youngest groups of men and women, living in

such areas even appears to have a beneficial effect now. This factor may well be identifying areas where student numbers have increased substantially between the 1980s and 1990s and where there are also higher numbers of young single people (often in professional and hence better-paid occupations). This indicator is also becoming a weaker measure of social relationships and there is no particular reason to believe that younger people who are married are any happier than those who are not (young marriages are more likely to dissolve, for instance). Areas where a high proportion of young people are married tended to be poorer places in the 1980s and 1990s, often coinciding with areas settled in the 1960s and 1970s by immigrants from South Asia. Being single at younger ages might well be becoming an indicator that helps differentiate between large groups of young people on different economic trajectories. If this is so and those trajectories are becoming more divergent, then this factor too might become more influential in the future, but as a proxy for 'hope' rather than as an indicator of 'happiness'.

What though for the future suicide rates of women? For migration, the effect for women mirrors that for men. For women living in areas where a higher than average proportion of women are not working, not working has less influence compared to men, except for women aged over 64, where a high proportion working appears to be detrimental. Women's geography of suicide under age 65 appears less related to their geography of employment and how that has changed over time. Finally, the impact of living in areas where a higher than average proportion of women are single appears to have the traditional negative influence, although that became slightly more muted in the 1990s. This is an interesting 'non-finding' in that for younger women there was much less growth in an apparently beneficial effect of living in areas which had a high proportion of single women in the 1990s as appeared to become the case for men.

To conclude, this study suggests different forces at work influencing suicide rates for men and women and that in many cases those ecological forces are strengthening. What then of the geographical distributions of suicides over the next decade for deaths recorded between 2001 and 2010? Given the strengthening in the impact of particular social conditions at particular ages for men, it would appear prudent to expect to see this trend continue and the spatial organization of society to become more important in determining the maps of male suicides. For women, the picture is more complex, and the preference amongst women for using methods of attempting suicide that are increasingly becoming less lethal in recent years may have helped make that picture more complex. If women begin using other more lethal methods to attempt suicide in the future, then a new and unpredictable pattern might well emerge.

What we have shown in total in this paper is that application of either a set of very simple linear regression equations or of more complex negative binomial regression produces a series of results which are plausible and which sum up to near identical models. These very closely predict the numbers of suicides that took place in each parliamentary constituency in Britain over the course of the last 20 years. The influence of each of the three measures of 'social integration' are very different for different age and sex groups, but differ in ways which are intuitively explicable. The spatial pattern of despair in Britain – as measured from the most extreme act of despair – can be predicted from three simple census measures, which may themselves be proxies for other influences and which do not necessarily imply that it is the group we are measuring that are at higher risk. People who have lived all their life in a place, have work and are married may be at greater risk of suicide if many of their neighbours have recently moved in, do not have work and are single. An ecological study such as this can only suggest possible individual influences, but those influences that we have suggested tend to be replicated by other studies we have referenced, many of which did not rely on ecological data.

What, though, might Emile Durkheim have made of these results (Lester 1994)? Whilst Durkheim investigated age and sex differences in suicide rates in relation to marital status, he made little comment on age and sex patterning of suicide with other measures of social integration. This may have been because of the limitations of the data available to him in the nineteenth century. The differing age and sex patterns of association with the three measures we have used in this analysis fits with the common-sense notion that in men compared to women and at different points in the lifecourse, the influence of some aspects of the social environment will vary. On this basis our findings may be seen as a major refinement to previous analyses of the geographic patterning of suicide. Such analyses are commonly based on overall (all ages and both male

and female) suicide rates (see, for example, Weyerer and Wiedenmann 1995). We end with an atomistic and then aggregate interpretation of our findings.

In short, if these ecological findings could be applied to the individual, then, to minimize your chances of suicide geographically, be single until the age of 25, then ensure that you are married and have a job. Try not to move home too often, but if you do so, do it before you are 35. Keep your job until you are at least 45, but do not work beyond 65; and keep hold of your partner for as long as you can . . . At the aggregate level of society, we need to strengthen social ties to protect people from the ill effects of migration, from unhappy relationships or from lack of relationships and to ensure that those who want work can work and those who don't want to work don't have to work, particularly in their old age. Reducing the aggregate level of suicide in Britain may, in essence, be as simple as that; but given a society largely run by men, official and unofficial policies designed to strengthen social ties, rather than strengthen market forces, may be some time coming.

Acknowledgements

We are grateful to Adam Tickell and to three anonymous referees for their extremely helpful comments on the first draft of this paper. We are also grateful to Bethan Thomas who helped to match the mortality data to parliamentary constituencies and Richard Mitchell for his previous work helping to correct the 1991 census for under-enumeration which allowed us to use reliable data in this paper, and to Jonathan Sterne for statistical advice.

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